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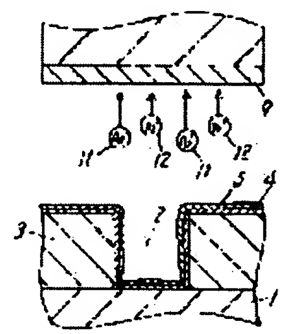
(54) MANUFACTURE OF ALUMINUM ALLOY WIRING LAYER

(57)Abstract:

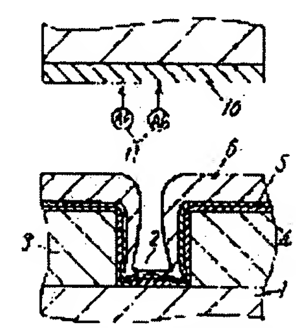
PURPOSE: To improve step-difference coverage of an aluminum alloy film in a contact hole.

CONSTITUTION: A titanium film 4 is formed on a contact hole 2 formed in a semiconductor substrate 1, by sputtering a titanium target with argon gas. After the titanium film 4 is formed, a titanium nitride film 5 is formed in a vacuum, by coninuously sputtering the titanium target with mixed gas of argon gas and nitrogen gas, without exposing the semiconductor substrate 1 to the air. The semiconductor substrate 1 is once exposed to the air. Again in a vacuum, the semiconductor substrate 1 is so heated that the surface temperature is in the range from 150°C to 250°C. In this state, an aluminum alloy film 6 is formed by sputtering an aluminum alloy target.

(a)



(b)



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CLAIMS

[Claim(s)]
[Claim 1] A manufacture method of an aluminum alloy wiring layer characterized by providing the following. A process which forms a titanium film by the sputtering method so that a contact hole prepared on a semiconductor substrate may be covered A process which forms a titanium nitride film by the sputtering method continuously in an after [formation] vacuum of said titanium film A process which opens a formation backward semiconductor substrate of said titanium nitride film to atmospheric air A process which forms an aluminum alloy film by the sputtering method while holding skin temperature of a semiconductor substrate in said after [atmospheric-air disconnection] vacuum within the limits of 150 to 250 degrees C
[Claim 2] A manufacture method of an aluminum alloy wiring layer characterized by providing the following. A process which forms a titanium film by the sputtering method so that a contact hole prepared on a semiconductor substrate may be covered A process which forms a titanium nitride film by the sputtering method continuously in an after [formation] vacuum of said titanium film A process which forms a titanium film by the sputtering method continuously in an after [formation] vacuum of said titanium nitride film A process which forms an aluminum alloy film by the sputtering method after opening a semiconductor substrate to atmospheric air in succession in a vacuum after formation of said titanium film
[Claim 3] A manufacture method of an aluminum alloy wiring layer characterized by providing the following. A process which forms a titanium film by the sputtering method so that a contact hole prepared on a semiconductor substrate may be covered A process which forms a titanium nitride film by the sputtering method continuously in an after [formation] vacuum of said titanium film A process which opens a formation backward semiconductor substrate of said titanium nitride film to atmospheric air A process which carries out sputtering of the aluminum alloy target by argon gas in an ambient atmosphere whenever [high vacuum / which made other partial pressure of gas except argon gas a value which does not exceed 1x10-8Torr after said atmospheric-air disconnection], and forms an aluminum alloy film

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[Translation done.]

* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the manufacture method of the aluminum alloy wiring layer used in order to connect during semiconductor substrate-wiring electrically.
[0002]
[Description of the Prior Art] While detailed-izing of a semiconductor device and integration progress in recent years, the path of a contact hole which connects between wiring with a semiconductor substrate electrically is making it detailed. Therefore, at the contact hole pars basilaris ossis occipitalis, there is a problem that the coat nature of an aluminum alloy wiring layer falls, and the reliability of an aluminum alloy wiring layer, such as poor electromigration and a poor stress migration, falls.
[0003] Below, drawing 4 is used and explained about the manufacture method of the conventional aluminum alloy wiring layer.
[0004] As for a semiconductor substrate and 2, in drawing, 1 is [a contact hole and 3] interlayer insulation films. A titanium film and 5 show a titanium nitride film, 6 shows the aluminum alloy film, and 4 will double these, and will only call it an aluminum alloy wiring layer.
[0005] First, in drawing 4 (a), the titanium film 4 is formed by the sputtering method on the contact hole 2 formed in the semiconductor substrate 1. And the titanium nitride film 5 is continuously formed by the sputtering method in a vacuum after formation of the titanium film 4, without exposing the semiconductor substrate 1 to atmospheric air. Then, at drawing 4 (b), the semiconductor substrate 1 is once exposed to atmospheric air, and the aluminum alloy film 6 is again formed for the semiconductor substrate 1 by the sputtering method by no heating in a vacuum. At this time, as for the aluminum alloy target used for sputtering, that presentation uses the thing of 3 element system of aluminum, 2 element system of silicon or aluminum, silicon, and copper. Moreover, formation of the aluminum alloy film 6 by the sputtering method is performed by impressing negative bias to an aluminum alloy target in argon gas. Thus, as the configuration in the contact hole pars basilaris ossis occipitalis of the formed aluminum alloy wiring layer is shown in drawing 4 (b), step coverage nature falls.
[0006]
[Problem(s) to be Solved by the Invention] However, by the above-mentioned conventional manufacture method, since the step coverage nature of the aluminum alloy wiring layer in contact hole 2 pars basilaris ossis occipitalis gets worse, reliability, such as electromigration resistance and stress migration resistance, falls.
[0007] This invention solves the above-mentioned conventional technical problem, and it becomes possible to raise the step coverage nature of an aluminum alloy wiring layer of it in contact hole 2 pars basilaris ossis occipitalis formed on the semiconductor substrate 1. Therefore, the manufacture method of a reliable aluminum alloy wiring layer is offered.
[0008]
[Means for Solving the Problem] In order to solve the above-mentioned technical problem a manufacture method of an aluminum alloy wiring layer of this invention A process which forms a

titanium film by the sputtering method so that a contact hole prepared on a semiconductor substrate may be covered, A process which forms a titanium nitride film by the sputtering method continuously in an after [formation] vacuum of a titanium film, It has a process which opens a formation backward semiconductor substrate of a titanium nitride film to atmospheric air, and a process which forms an aluminum alloy film by the sputtering method while holding skin temperature of a semiconductor substrate in a vacuum after atmospheric-air disconnection within the limits of 150 to 250 degrees C.
[0009] Moreover, a process which forms a titanium film by the sputtering method so that a contact hole prepared on a semiconductor substrate may be covered, A process which forms a titanium nitride film by the sputtering method continuously in an after [formation] vacuum of a titanium film, After a process which forms a titanium film by the sputtering method continuously in an after [formation] vacuum of a titanium nitride film, and formation of a titanium film, after opening a semiconductor substrate to atmospheric air in succession in a vacuum, it has a process which forms an aluminum alloy film by the sputtering method.
[0010] Furthermore, a process which forms a titanium film by the sputtering method so that a contact hole prepared on a semiconductor substrate may be covered, A process which forms a titanium nitride film by the sputtering method continuously in an after [formation] vacuum of a titanium film, A process which opens a formation backward semiconductor substrate of a titanium nitride film to atmospheric air, and after atmospheric-air disconnection, It has a process which carries out sputtering of the aluminum alloy target by argon gas in a high vacuum ambient atmosphere of a value which does not exceed 1x10-8Torr for other partial pressure of gas except argon gas, and forms an aluminum alloy film.

[0011]
[Function] Since it becomes possible to raise the step coverage nature of an aluminum alloy wiring layer in the pars basilaris ossis occipitalis of the contact hole formed on the semiconductor substrate according to this invention, it becomes possible to raise reliability, such as electromigration resistance, stress migration resistance, etc. of an aluminum alloy wiring layer.
[0012]
[Example] Below, it explains, referring to a drawing about the example of the manufacture method of the aluminum alloy wiring layer of this invention.
[0013] Drawing 1 is the order cross section of a process of the 1st example of the manufacture method of the aluminum alloy wiring layer of this invention.
[0014] drawing -- setting -- 1 -- a semiconductor substrate and 2 -- a contact hole and 3 -- an interlayer insulation film and 4 -- a titanium film and 5 -- in a titanium nitride film and 6, an aluminum alloy target and 11 show argon gas, and, as for an aluminum alloy film and 9, 12 shows nitrogen gas, as for a titanium target and 10. In the example, the titanium film 4, the titanium nitride film 5, and the aluminum alloy film 6 will be set, and it will be called an aluminum alloy wiring layer.
[0015] First, in drawing 1 (a), on the contact hole 2 formed in the semiconductor substrate 1, sputtering of the titanium target is carried out by argon gas, and the titanium film 4 is formed at the thickness of 200A. And after formation of the titanium film 4, without exposing the semiconductor substrate 1 to atmospheric air, sputtering of the titanium target is continuously carried out with the mixed gas of argon gas and nitrogen gas in a vacuum, and the titanium nitride film 5 is formed in the thickness of 1000A. Then, in drawing 1 (b), the semiconductor substrate 1 is once exposed to atmospheric air, sputtering of the aluminum alloy target is carried out by argon gas, carrying out heating maintenance of the skin temperature of the semiconductor substrate 1 in a vacuum again within the limits of 150 to 250 degrees C, and the aluminum alloy film 6 is formed in the thickness of 10000A. At this time, as for the aluminum alloy target used for sputtering, that presentation uses the thing of 3 element system of aluminum and 2 element system of silicon or aluminum, silicon, and copper. Moreover, the content of the silicon in an aluminum alloy target uses 0.1 to 3% of thing with a mass ratio. The aluminum alloy obtained by making aluminum contain silicon can make the melting point lower than pure aluminum. Therefore, the migration (migration) of the aluminum alloy film 6 is promoted for the skin temperature of a semiconductor substrate on the semiconductor substrate 1 within the limits of 150 to 250 degrees C,

and the step coverage nature in a contact hole 2 improves. Therefore, reliability in a contact hole 2, such as electromigration resistance, stress migration resistance, etc. of an aluminum alloy wiring layer, improves.

[0016] Drawing 2 is the order cross section of a process of the 2nd example of the manufacture method of the aluminum alloy wiring layer of this invention.

[0017] drawing -- setting -- 1 -- a semiconductor substrate and 2 -- a contact hole and 3 -- an interlayer insulation film and 4 -- a titanium film and 5 -- a titanium nitride film and 6 -- in an aluminum alloy film and 7, an aluminum alloy target and 11 show argon gas, and, as for a titanium film and 9, 12 shows nitrogen gas, as for a titanium target and 10. In the example 2, the titanium film 4, the titanium nitride film 5, the aluminum alloy film 6, and the titanium film 7 will be set, and it will be called an aluminum alloy wiring layer.

[0018] First, in drawing 2 (a), on the contact hole 2 formed in the semiconductor substrate 1, sputtering of the titanium target is carried out by argon gas, and the titanium film 4 is formed at the thickness of 200A. And sputtering of the titanium target is continuously carried out with the mixed gas of argon gas and nitrogen gas in a vacuum after formation of the titanium film 4, without exposing the semiconductor substrate 1 to atmospheric air, and the titanium nitride film 5 is formed in the thickness of 1000A. Furthermore, after formation of the titanium nitride film 5, sputtering of the titanium target is continuously carried out by argon gas again in a vacuum, without exposing the semiconductor substrate 1 to atmospheric air, and the titanium film 4 is formed in the thickness of 200A. Then, in drawing 2 (b), once exposing the semiconductor substrate 1 to atmospheric air, and carrying out heating maintenance of the skin temperature of the semiconductor substrate 1 in a vacuum again within the limits of 150 to 250 degrees C, sputtering of the aluminum alloy target is carried out by argon gas, and the aluminum alloy film 6 is formed in the thickness of 10000A. At this time, as for the aluminum alloy target used for sputtering, that presentation uses the thing of 3 element system of aluminum and 2 element system of silicon or aluminum, silicon, and copper. Moreover, the content of the silicon in an aluminum alloy target uses 0 to 3% of thing with a mass ratio. Especially in this invention, even if it does not make an aluminum alloy target contain silicon, what has the equivalent step coverage nature in 1st example and contact hole 2 pars basilaris ossis occipitalis is obtained. On the other hand, if the aluminum alloy which made silicon contain is used, step coverage nature comparable as the 1st example will be obtained also by no heating in a semiconductor substrate. Therefore, reliability in a contact hole 2, such as electromigration resistance, stress migration resistance, etc. of an aluminum alloy wiring layer, improves.

[0019] Drawing 3 is the order cross section of a process of the 3rd example of the manufacture method of the aluminum alloy wiring layer of this invention.

[0020] drawing -- setting -- 1 -- a semiconductor substrate and 2 -- a contact hole and 3 -- an interlayer insulation film and 4 -- a titanium film and 5 -- for impurity gas or residual gas, and 9, as for an aluminum alloy target and 11, a titanium target and 10 are [a titanium nitride film and 6 / an aluminum alloy film and 8 / argon gas and 12] nitrogen gas. In the example 3, the titanium film 4, the titanium nitride film 5, and the aluminum alloy film 6 will be set, and it will be called an aluminum alloy wiring layer.

[0021] First, in drawing 3 (a), on the contact hole 2 formed in the semiconductor substrate 1, sputtering of the titanium target is carried out by argon gas, and the titanium film 4 is formed at the thickness of 200A. And sputtering of the titanium target is continuously carried out with the mixed gas of argon gas and nitrogen gas in a vacuum after formation of the titanium film 4, without exposing the semiconductor substrate 1 to atmospheric air, and the titanium nitride film 5 is formed in the thickness of 1000A. Then, in drawing 3 (b), the semiconductor substrate 1 is once exposed to atmospheric air, sputtering of the aluminum alloy target is again carried out by argon gas in a vacuum, and the aluminum alloy film 6 is formed in the thickness of 10000A. Vacuum length is carried out with the cryopump etc. until the partial pressure of the impurity gas contained in argon gas or residual gas is set to 1x10 to 8 or less Torrs at the time of aluminum alloy film 6 formation. Thus, by stopping impurity gas pressure low, the migration (migration) of the aluminum alloy film 6 is promoted on the semiconductor substrate 1, and the step

coverage nature in a contact hole 2 improves. Therefore, reliability in a contact hole 2, such as electromigration resistance, stress migration resistance, etc. of an aluminum alloy wiring layer, improves.

[0022] in addition, after carrying out heating maintenance of the skin temperature of the semiconductor substrate 1 within the limits of 150 to 250 degrees C after forming three layer membranes of titanium-titanium nitride-titanium, and setting impurity gas pressure to 1x10 to 8 or less Torrs further, the synergistic effect shows up by forming the aluminum alloy film 6, and the step coverage nature in a contact hole 2 is markedly alike, and improves.

[0023]

[Effect of the Invention] According to this invention as mentioned above, the step coverage nature of the aluminum alloy film in the contact hole formed on the semiconductor substrate was able to be raised.

[0024] First, in the 1st example, since the migration (migration) in the contact hole of an aluminum alloy becomes active and step coverage nature improves by forming an aluminum alloy film by the sputtering method, heating a semiconductor substrate to the temperature of within the limits from 150 degrees C to 250 degrees C, electromigration resistance and stress migration resistance improve.

[0025] In the 2nd example, three layer membranes of titanium-titanium nitride-titanium are used as a substrate. Consequently, the substrate front face at the time of aluminum alloy film formation serves as titanium. Without heating the front face of a semiconductor substrate, since it becomes more active on titanium than a titanium nitride top, the migration of an aluminum alloy becomes possible [obtaining the step coverage nature which was excellent in the contact hole], and electromigration resistance and its stress migration resistance improve.

[0026] In the 3rd example, by holding down low the impurity gas pressure at the time of aluminum alloy film formation to 1x10 to 8 or less Torrs, since concentration of the impurity caught in an aluminum alloy film can be lessened, the migration (migration) of the aluminum alloy in a contact hole becomes active, and step coverage nature improves. Furthermore, since the grain growth of an aluminum alloy film is not checked, electromigration resistance and stress migration resistance improve more, because the high impurity concentration in an aluminum alloy film decreases.

[Translation done.]